Neonatal Thermoregulation

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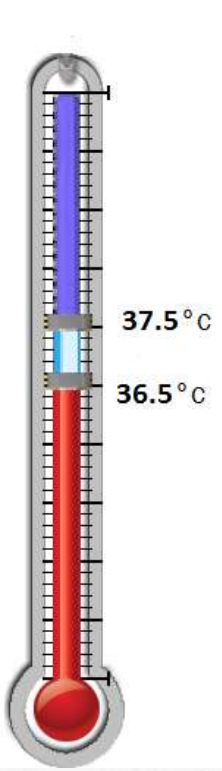
Introduction

- Thermoregulation in the neonate is a critical physiological function
- The neonate is susceptible to acute effects of thermal instability because
  - physical immaturity
  - environmental factors
  - extent of illness

Objectives

- Hypothermia & Hyperthermia
  - Risk factors
  - Mechanisms of heat loss
  - Mechanism of heat production
  - Manifestations

Definition



WHO classification

- **Hyperthermia** - > 37.5°C
- **Hypothermia** - <36.5°C
  - **mild** hypothermia - (Cold stress) 36°C - 36.4°C
  - **moderate** hypothermia - 35.9°C - 32°C
  - **severe** hypothermia - <32°C

Method of temperature taking

- Low reading thermometer
- Use axillary measurements
- Should be checked every 4 to 6 hours
- Should be checked every hour if temperature is outside normal range

Hypothermia

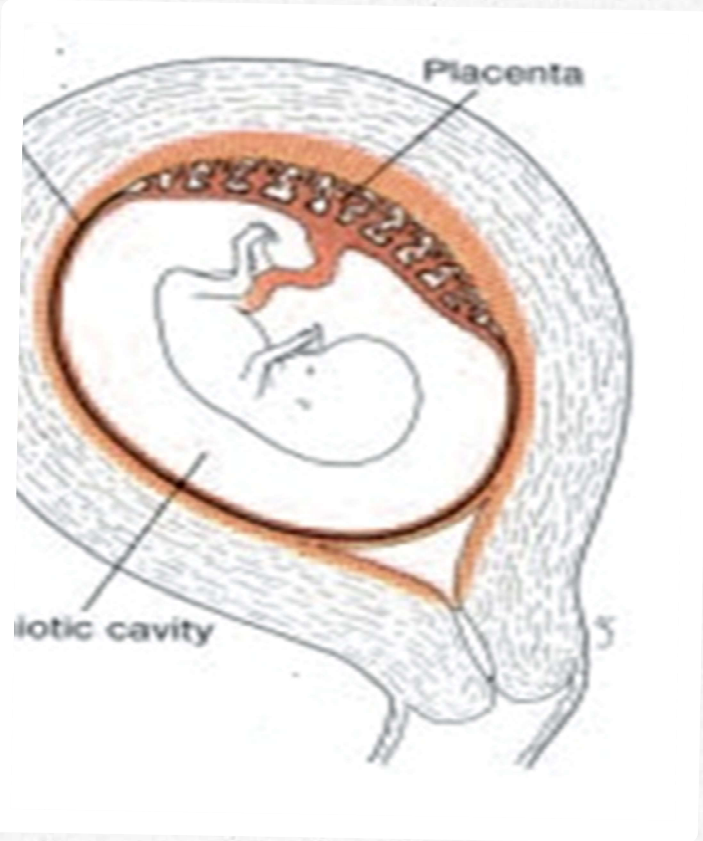
Epidemiology

- Hypothermia at birth is a worldwide problem
- All neonates are at risk of hypothermia within the first twelve hours of life

Thermoregulation in utero

- **Placenta** acts as heat exchanger

- Fetal temperature is higher than the mother's



Thermoregulation after birth

→ amniotic fluid

→ cold & dry env't

→ decrease by 0.1°C/min

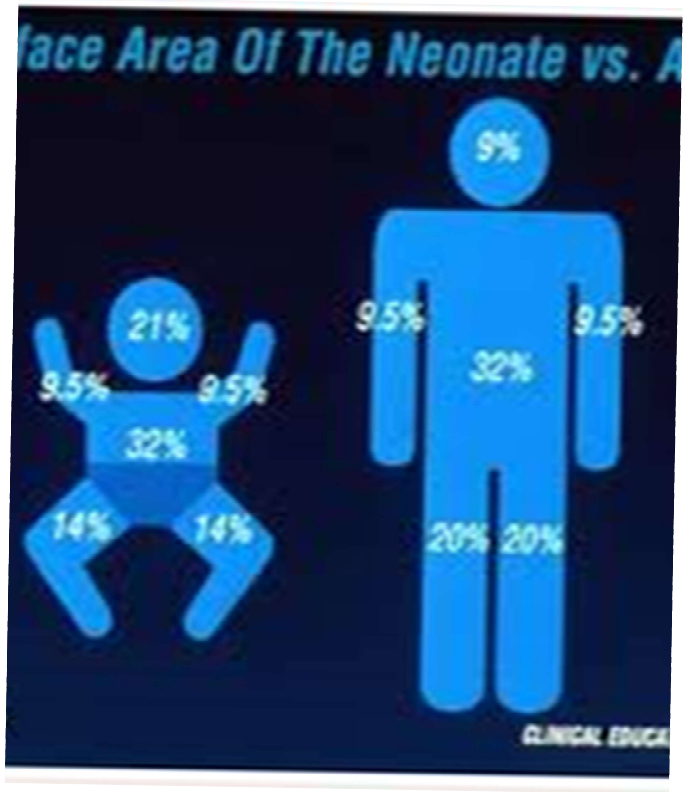
→ NTE – if not maintained neonate will have to increase metabolism

Risk Factors

→ Small body mass in relation to surface area

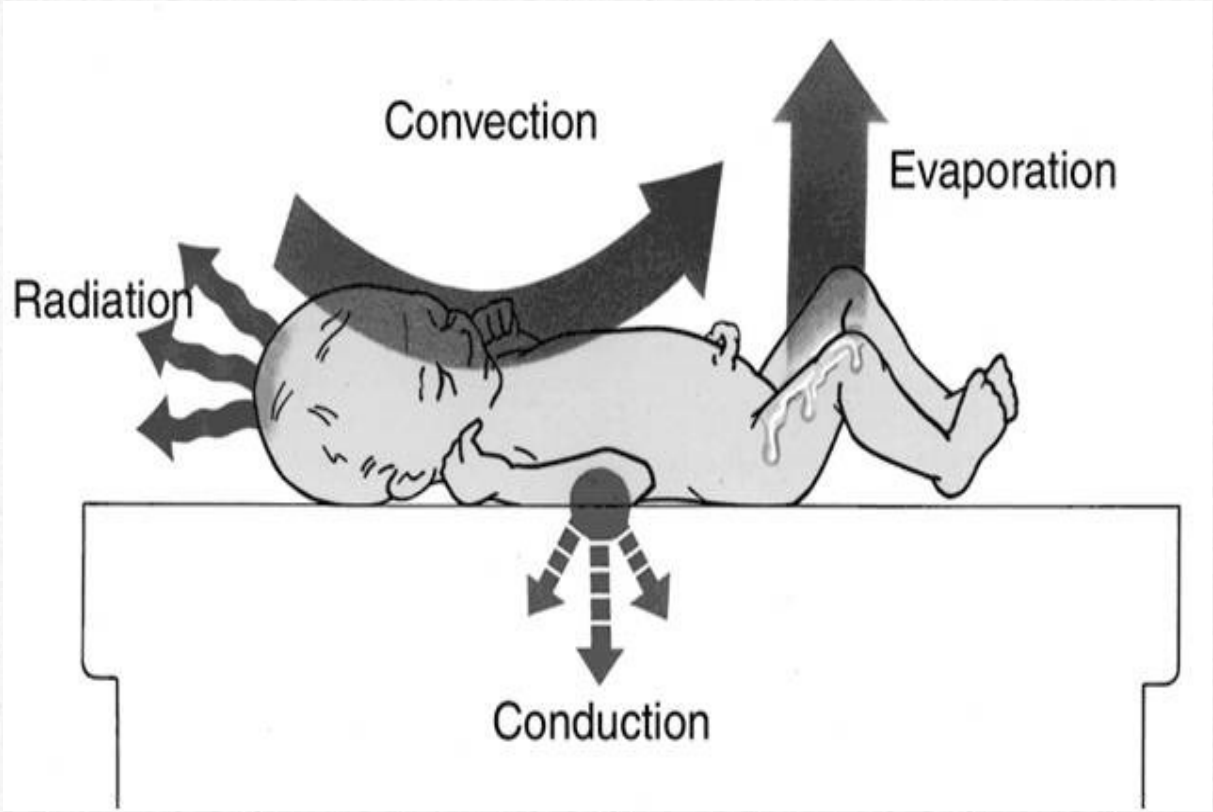
→ Subcutaneous fat is thinner

→ Stratum corneum is poorly keratinized



Mechanism of Heat loss

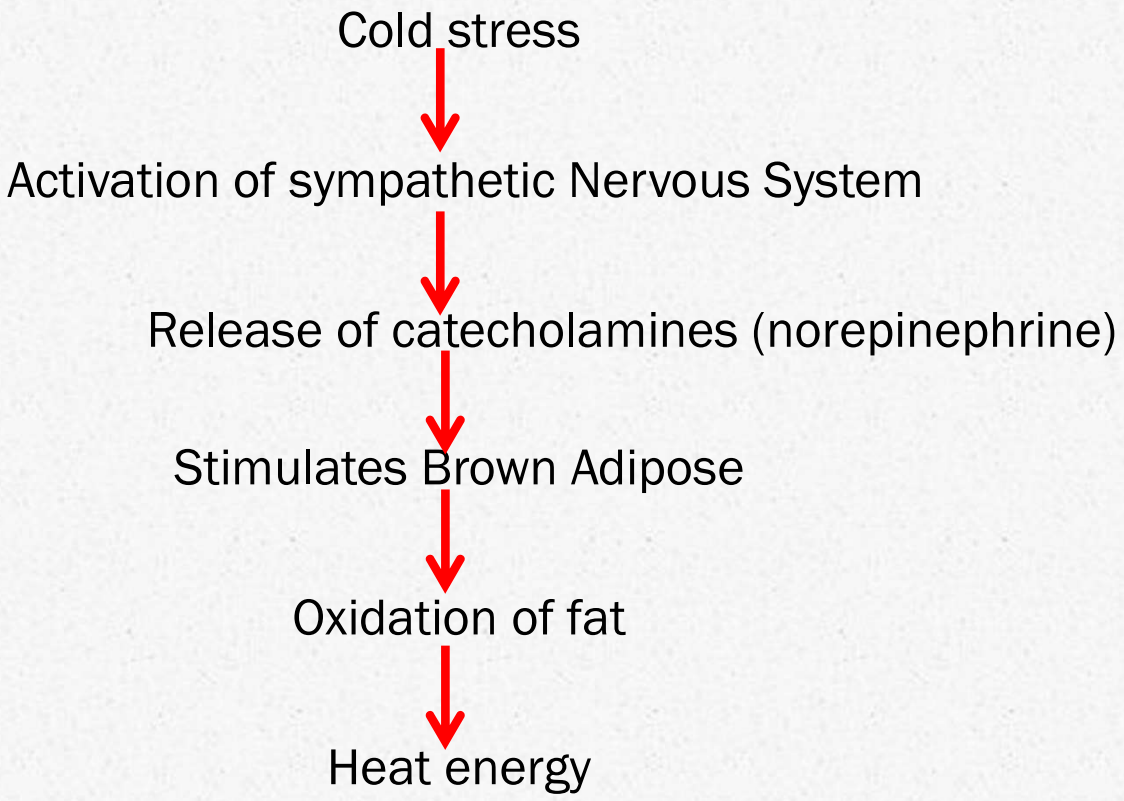
- Convection - cooler surrounding air
- Conduction - colder materials on which the infant is resting
- Radiation - nearby cooler solid objects
- Evaporation - major factor from moist skin and lungs


Convection
Evaporation
Radiation
Conduction

Mechanism of Heat Production

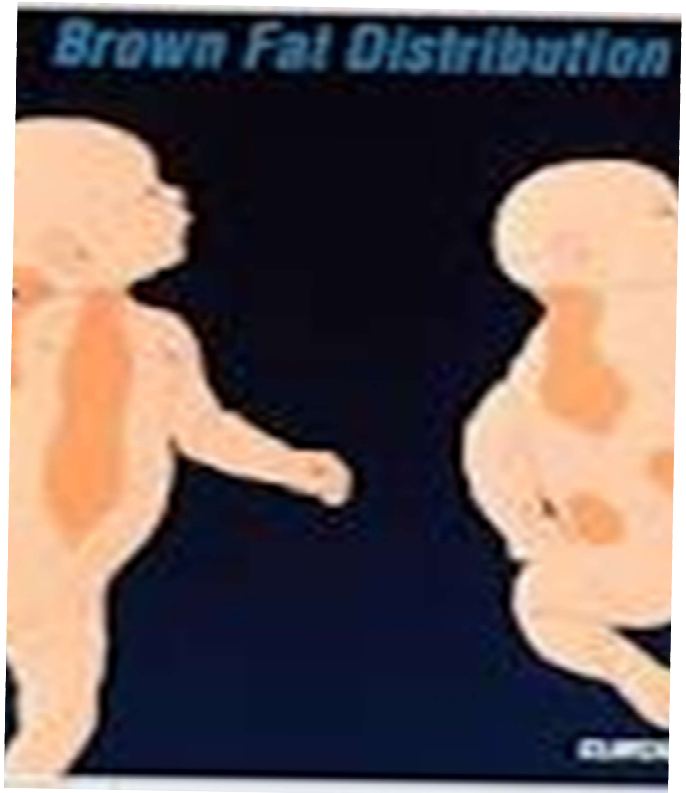
- Peripheral vasoconstriction
- Increase in muscular activity (**Shivering**) – below 25°C
- **Non-shivering thermogenesis** (Predominant in neonates)

Non-Shivering thermogenesis



Brown fat

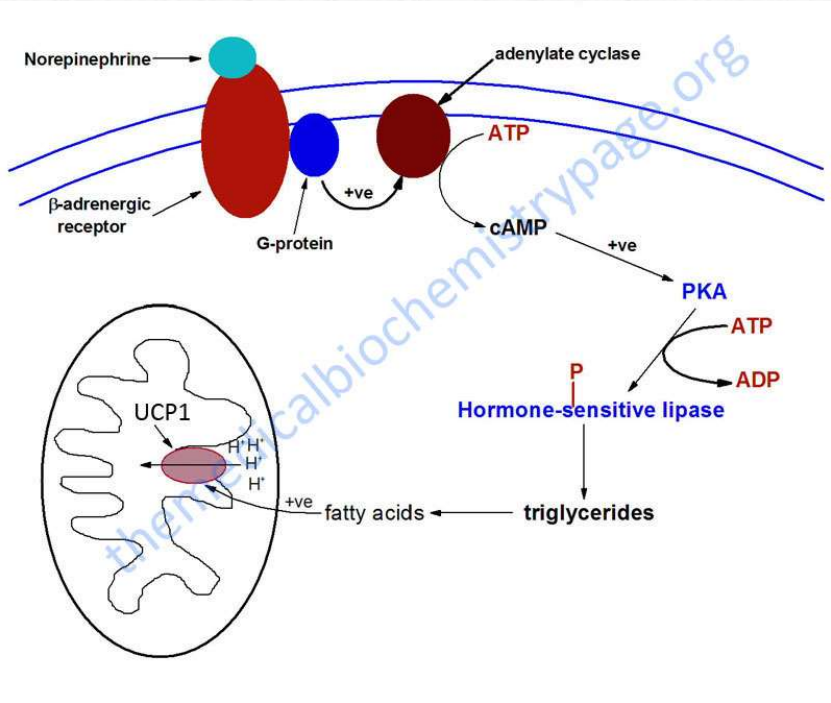
- → 4 % of the body mass
- → Identified after 26 weeks
- → **prominent around large blood vessels**
  - neck
  - Thorax
  - Intra-scapular regions
  - around the kidneys



Brown Fat (Contd.)

- contains
  - high levels of **triglycerides** (fat vacuoles)
  - many **mitochondria** per cell
  - rich in **capillaries**
  - innervated by **sympathetic** nerve fibers

Heat generation in brown adipocytes



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- NE Binds β3 adrenoreceptors
- G-protien coupled activation of cAMP which in turn activates protein kinase
- PKA activates hormone-sensitive lipase
- Oxidative phosphorylation

Triglycerides

- Glycerol
- Fatty acid
  - 30% oxidized to generate heat
  - 60% esterified
  - 10% released into the circulation

Causes

External factors

- convection
  - Exposed (not wrapped)
  - During transportation
- conduction
  - weighing scales
  - stethoscope
- radiation
  - Cold room
- Evaporation
  - Wet skin (not dried)
  - bathing early
  - trans-epidermal heat loss (large surface area and poor insulation)

Causes (Contd.)

Decreased heat production

- metabolic rate
  - Pre-term
  - hypoglycemia
- Oxygen consumption
  - Any Condition causing respiratory Distress
- Release of norepinephrine
  - neurologic defect
  - CNS depression (asphyxia)

Causes

- Neonatal Sepsis
- The preterm infant has disadvantages of
  - Decreased brown fat
  - decreased fat for insulation
  - immature skin
  - poor vascular control
  - Decreased glycogen store
  - a lower maximal metabolism

Manifestations

- Metabolic
  - Metabolic acidosis
  - Hypoglycemia
  - Poor weight gain
- Respiratory
  - hypoxia
  - tachypnea

Manifestations

- CNS
  - Bradycardia
  - Apnea
- CVS
  - Peripheral Vasoconstriction
    - Cold extremities
    - pink skin color
  - increased renal excretion of water and solutes
  - Tachycardia
  - increased capillary refill time

Management

Reducing heat loss

- Warm
- Dry the baby
- Wrap in blankets
- Skin-to-skin contact with the mother (kangaroo method)

Management

Reducing heat loss

- placing under a warmer
  - Incubator
  - radiant or convective heat source

Management (Contd.)

Supplementing thermogenesis

- → Breast feeding
- → IV fluid and glucose
- → Oxygen
- → Monitor blood gas and oxygen saturation

-Resuscitation

-Promote a flexed position (conserve heat)

Hyperthermia

Risk Factor

- Sweating is uncommon in newborns and may be noted only on the forehead.

Cause

- warmly dressed
- infants left near stoves or radiators
- left in automobiles, or left with bright sunlight shining directly on them

Cause

- usually secondary to overheating due to an external source
- Sepsis
- maternal hyperthermia

Manifestation

- Hot and dry skin
- restlessness, irritable
- Tachypnea
- Flushing, hypotension
- dehydration (fluid loss)
- Decreased urine output
- Seizure (hypernatremia)
- tachycardia
- Abnormal posturing
- Poor feeding

Manifestation

- Extreme Cases
  - sudden infant death
  - hemorrhagic shock (heat stroke)
  - encephalopathy syndrome

Management

- Lower the environmental temperature
- Remove excess layers and clothing.
- Administering oral or parenteral fluids
- Treat infection

Reference

- Nelson Textbook of pediatrics, 18th edition
- Up To Date, 19.1
- Olsson E., Neonatal cold injury

Thank You!